



# Pleistocene and Recent Mediterranean species of *Granulina* (Gastropoda, Marginellidae), with description of four new species

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**KEY WORDS:** *Granulina*, Marginellidae, systematics, new species, Mediterranean, Pleistocene, Recent.

**ABSTRACT** Eleven species of *Granulina* Jousseume, 1888 are reported from the Mediterranean Quaternary: *G. rosarioi* n. sp., *G. jbmisensis* n. sp., *G. ovulina* (Monterosato, 1891), *G. tenuilabiata* n. sp., *G. occulta* (Monterosato, 1869), *G. marginata* (Bivona, 1832), *G. boucheti* Gofas, 1992, *G. minusculina* (Locard, 1897), *G. gofasi* Smriglio & Mariottini, 1996, *G. guttula* n. sp. and *G. melitensis* Smriglio, Mariottini & Rufini, 1998. Six species are Pleistocene to Recent, i.e. *G. tenuilabiata* n. sp., *G. occulta*, *G. marginata*, *G. boucheti*, *G. minusculina* and *G. gofasi*, while *G. jbmisensis* n. sp., *G. ovulina* and *G. rosarioi* n. sp., are only known from the Pleistocene. Two species, *G. melitensis* and *G. guttula* n. sp., are only known as Recent species. Main evolutionary trends of *Granulina* in the Mediterranean are: colonisation of the outer shelf and the upper slope, endemism and high speciation rate.

**RIASSUNTO** Per il Quaternario del Mediterraneo sono riportate undici specie del genere *Granulina* Jousseume, 1888, quattro delle quali nuove: *G. rosarioi* n. sp., *G. jbmisensis* n. sp., *G. ovulina* (Monterosato, 1891), *G. tenuilabiata* n. sp., *G. occulta* (Monterosato, 1869), *G. marginata* (Bivona, 1832), *G. boucheti* Gofas, 1992, *G. minusculina* (Locard, 1897), *G. gofasi* Smriglio & Mariottini, 1996, *G. guttula* n. sp. e *G. melitensis* Smriglio, Mariottini & Rufini, 1998. *G. rosarioi* n. sp. e *G. jbmisensis* n. sp. sono note solo per il Pleistocene, la prima per depositi di piattaforma profonda della Sicilia sud-occidentale, la terza per depositi superficiali della Sicilia sud-orientale. *G. tenuilabiata* n. sp. è specie epibatiale nota per il Pleistocene della Calabria meridionale e per una stazione al largo della Sardegna orientale, probabilmente di età würmiana. *G. guttula* n. sp. è nota solo per una stazione al largo dell'Isola di Ponza (Tirreno centrale) ad 84 m. Per il Pleistocene vengono riportate anche *G. minusculina*, *G. marginata*, *G. boucheti*, *G. gofasi* e *G. ovulina*; per quest'ultima viene designato il lectotipo. Uniche specie francamente superficiali (infralitorali) sono *G. marginata*, *G. boucheti* e *G. jbmisensis* n. sp., nessuna delle quali, comunque, mostra particolari affinità verso le specie del vicino Atlantico. Fra le altre specie sembrano riconoscibili dei gruppi, cioè il gruppo *rosarioi-ovulina-guttula-occulta*, il gruppo *gofasi-tenuilabiata* ed il gruppo *melitensis-minusculina*. Il primo gruppo ha distribuzione tipicamente circalitorale, mentre gli altri due hanno distribuzione più profonda, ma solo *G. minusculina* ha distribuzione francamente batiale.

Alcuni problemi restano aperti, ed in particolare il significato tassonomico di una forma pleistocenica che sembra rappresentare il ceppo dal quale *G. marginata* e *G. boucheti* si sono differenziate nel corso del Quaternario. Le principali tendenze evolutive del genere *Granulina* nell'area Mediterranea sono rappresentate da tendenza a colonizzare ambienti della piattaforma profonda ed epibatiale, spiccata endemism e veloce tasso di speciazione.

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## INTRODUCTION

The genus *Granulina* Jousseume, 1888 includes small ovate, colourless and smooth-shelled "marginelliform" gastropods. The last whorl envelopes the previous ones, the lip is thickened, inflected and usually denticulate. Four columellar plications and a parietal callus are present. As stressed by GOFAS (1992), species identification needs careful examination of shell shape, lip, denticles, columellar plications, etc. In the present work, a diagnostic value is also stressed for the parietal callus.

Traditionally included in Marginellidae Fleming, 1828 (e.g. COAN, 1965; GOFAS, 1992), *Granulina* was recently transferred to Cystiscidae Stimpson, 1865 by COOVERT & COOVERT (1995). Marginellidae and Cystiscidae prove to be not as closely related as previously thought, the former sharing instead relations to Volutidae and the latter to Olividae (COOVERT & COOVERT, 1995). Anyway, there is not fully agreement about the allocation of *Granulina* in Cystiscidae (S. GOFAS, pers. com.). *Granulina* has a simple bifurcate head ("Type 2 animal" of COOVERT & COOVERT, 1995), strongly pointing to the Marginellidae. The "modified cystiscid internal whorls", mostly resorbed, of *Granulina* [which led COOVERT & COOVERT (1995) to rise the subfamily Granulininae] may be convergent to Cys-

tiscidae due to the small size of the genus. COOVERT & COOVERT (1995) also stressed radular peculiarities of *Granulina*, but no other anatomical information is available. At present, the move of *Granulina* to Cystiscidae seems not well supported and the allocation in Marginellidae is then maintained.

The Eastern Atlantic and Mediterranean species of *Granulina* were reviewed by GOFAS (1992), who checked four species from the Mediterranean (excluding Gibraltar), i.e. *G. marginata* (Bivona, 1832), *G. boucheti* Gofas, 1992, *G. occulta* (Monterosato, 1869) and *G. minusculina* (Locard, 1897). A fifth Mediterranean species, *G. gofasi*, was described by SMRIGLIO & MARIOTTINI (1995) and a sixth one, *G. melitensis*, by SMRIGLIO *et al.* (1998). The European species of *Granulina* were previously accounted by VAN AARTSEN *et al.* (1984), CONTRERAS (1987) and MUÑIZ SOLIS (1987). BOUCHET & WARÉN (1985) reported *Granulina* from the Northeast Atlantic deep waters.

Little is known about the fossil Mediterranean species. The past records of two species from the Plio-Pleistocene, i.e. *G. clandestina* (Brocchi, 1814) and *G. occulta* (Monterosato, 1869), prove to be mostly based on incorrect interpretations of these species and on a general poor knowledge of this genus (see GOFAS, 1992).



## MATERIAL AND METHODS

Descriptive terminology and morphometry is mainly based on GOFAS (1992) and COOVERT & COOVERT (1995). Descriptions and measurements are based on full-grown specimens. The examined Recent material consists all of empty shells. The following abbreviations are used:

- L = shell length  
D = shell maximum diameter  
L/D = length to maximum diameter ratio  
Ld = distance of maximum diameter from anterior ending  
Ld/L = relative position of maximum diameter  
sh(s) = shell(s)  
coll. = collection  
UPMC = University Paleontological Museum, Catania  
ZMR = Zoological Museum, Rome.

## SYSTEMATIC ACCOUNT

Class Gastropoda Cuvier, 1797  
Order Neogastropoda Thiele, 1929  
Family Marginellidae Fleming, 1828

Genus *Granulina* Jousseume, 1888

### Type-species

*Marginella pygmaea* Issel, 1869 (by monotypy)

*Granulina rosarioi* n. sp.

Figs. 1-3

### Type material

Holotype and 2 paratypes (both partly broken). UPMC.

### Type locality

Pleistocene deep-shelf silts cropping out along the Belice River valley ("Case Catarinichia"), southwestern Sicily.

### Etymology

Named for the author's father, Rosario.

### Description

Shell ovoid-elongate (L/D 1.46-1.50), outline well rounded. Posterior rostration well defined. Maximum diameter posterior to half shell length (Ld/L 0.63-0.65). Siphonal notch very weak. Lip markedly thickened, posteriorly bevelled; denticles well defined. Parietal callus narrow, making a deep and wide sinus on body-whorl. Aperture narrow. Four notably broad columellar plications, the uppermost two weaker. Surface smooth, polished. Holotype: L 3.07 mm, D 2.10 mm. Paratypes: L 3.10-3.15 mm, D 2.05 mm.

### Distribution

Only known from the type locality. *G. clandestina* and *G. occulta*, formerly listed from this locality (DI GERONIMO *et al.*, 1994,

tab. 2), now prove to be *G. rosarioi* and *G. gofasi*. Silts are overlaid by shallow-shelf coarse beds, which yielded *G. marginata* and *G. boucheti*.

### Remarks

*G. rosarioi* is somewhat similar to *G. gofasi*. In the former the lip is thicker and bevelled ("labre biseauté" of GOFAS, 1992) and the posterior rostration is sharper. The broad columellar plications are also distinctive to *G. rosarioi*.

*Granulina jbmisensis* n. sp.

Figs. 29-32

### Type material

Holotype and 11 paratypes (one subadult, 6 juveniles). UPMC.

### Type locality

Pleistocene shallow-shelf muddy-sandy beds cropping out near Còmiso ("Cartiera Mulino"), along the Ippari River valley, southeastern Sicily.

### Other examined material

Grammichele ("Catallarga"), southeastern Sicily, Pleistocene, 1 sh.

### Etymology

Named from *Jbmisus*, ancient name of Còmiso.

### Description

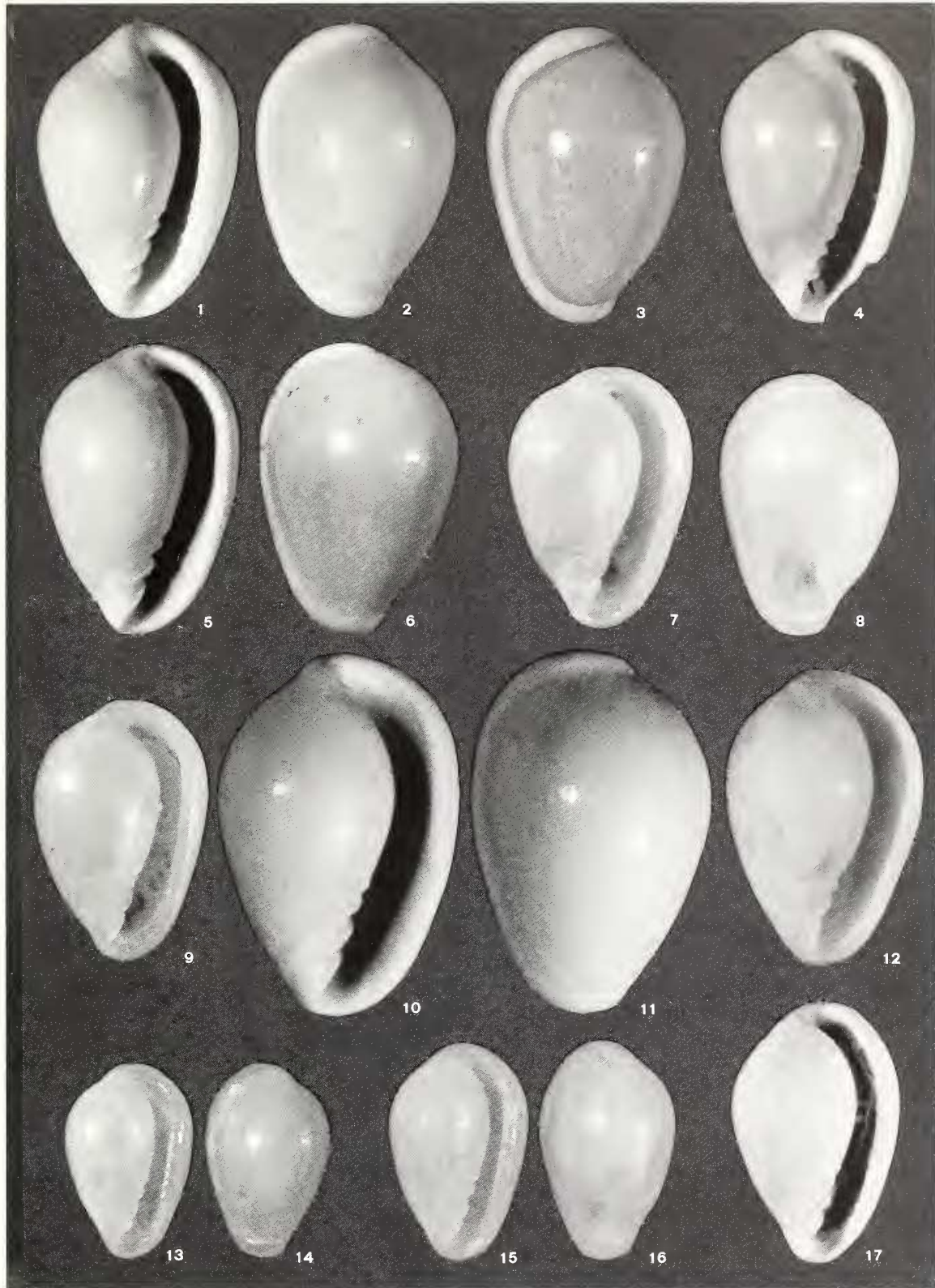
Shell ovoid-elongate (L/D 1.47-1.56), outline weakly rounded. Posterior ending rather truncated. Maximum diameter well posterior to half shell length (Ld/L 0.70-0.71). Siphonal notch distinct. Lip moderately thickened; denticles well defined. Aperture narrow. Four columellar plications, strongly doubled into an outer and an inner series. Outer plications partly merged to form a zigzag, the uppermost two weaker. Surface polished, smooth. Parietal callus wide, making a shallow sinus on body-whorl and an axial ridge almost inside aperture. Holotype: L 2.71 mm, D 1.84 mm. Paratypes: L 2.56-2.71 mm, D 1.82-1.64 mm.

### Distribution

The type material comes from fine-grained beds, rich in small-sized molluscs (mainly rissoids and *Bittium*), for which a shallow-water bottom sheltered by *Posidonia oceanica* grasses is inferred (COSTA, 1989). The single shell from Grammichele comes from shallow-water coarse beds (see LA PERNA, 1997).

### Remarks

Due to its elongate shape, *G. jbmisensis* appears similar to *G. occulta*. The former differs mainly by a less slender shape, a well distinct posterior slope-break, a more bevelled lip and by being almost non-rostrated. An ill-defined sulcus makes the columellar folds strongly doubled, as known for other species (see GOFAS, 1992, p. 4).



Figures 1-3. *Granulina rosarioi* n. sp. Belice River valley, Pleistocene. 1, 2. Holotype, 3.07x2.10 mm. 3. Paratype, 3.10x2.05 mm (oral side broken). Figures 4-6. *Granulina gofasi* Smriglio & Mariottini, 1996. Belice River valley, Pleistocene. 4. 3.01x1.99 mm. 5, 6. 2.98x2.04 mm. Figs. 7-9. *Granulina gofasi* Smriglio & Mariottini, 1996. Off Lazio coast, 550 m. 7, 8. 2.64x1.88 mm. 9. 2.68x1.82 mm. Figures 10, 11. *Granulina tenuilabiata* n. sp. Vallone Catrica, Pleistocene. Holotype, 3.43x3.05 mm. Figures 12. *Granulina tenuilabiata* n. sp. Off eastern Sardinia, 1281-330 m. 2.30x2.05 mm. Figures 13-16. *Granulina guttula* n. sp. Off Isola di Ponza, 84 m. 13, 14. Holotype, 1.92x1.26 mm. 15, 16. Paratype, 2.13x1.38 mm. Figures 17. *Granulina* sp. A. Vallone Catrica, Pleistocene. 2.71x1.71 mm.



### *Granulina ovulina* (Monterosato, 1891)

Figs. 43, 44

*Gibberulina ovulina* Monterosato, 1891: p. 4.

#### Examined material

Ficarazzi (Palermo), northwestern Sicily, Pleistocene, 145 shs. Lectotype designated by C. Smriglio & R. La Perna (May 1998). ZMR, Monterosato coll., 15/5-17197/A.

#### Description

Shell ovoid-elongate (L/D 1.63-1.65), outline rounded. Maximum diameter posterior to half shell length (Ld/L 0.65-0.67). Posterior rostration weak. Siphonal notch very weak. Lip thickened; denticulations well developed. Parietal callus hardly distinct, narrow, making a wide and deep sinus on body-whorl. Aperture narrow. Four strong columellar plications. Surface polished, smooth, with ill-defined growth striae. Lectotype: L 3.30 mm, D 2.10 mm. Largest specimen: L 3.80 x D 2.30 mm.

#### Distribution

Only known from the original material. The Ficarazzi beds contain Pleistocene deep-shelf faunas with scarce epibathyal species (see DI GERONIMO & LA PERNA, 1997: p. 417).

#### Remarks

*Gibberulina ovulina* was reported as a fossil from Ficarazzi (Palermo) by MONTEROSATO (1891), with a brief and vague description: "Bellissima forma del gruppo della *G. occulta* ma assai più grande" [A very nice form of the *G. occulta* group, but much larger]. *G. ovulina* is indeed rather similar to *G. occulta*, but markedly larger and more inflated. Due to its size, *G. ovulina* appears notably similar to *G. tenuilabiata* n. sp., but the two species differ in several respects: *G. tenuilabiata* is more inflated and rostrated than *G. ovulina*, the lip is notably thicker, less arched and slightly bevelled posteriorly, the aperture is narrower and with well developed denticulations.

The date of *G. ovulina* is labelled as "1896" (Fig. 45), but this was probably due to a misspelling for "1891".

### *Granulina tenuilabiata* n. sp.

Figs. 10-12

#### Type material

Holotype. UPMC.

#### Type locality

Epibathyal muddy beds cropping out at Vallone Catrica, southern Calabria, Pleistocene.

#### Other examined material

Off eastern Sardinia, BS78/2, 41°51'.03N, 10°34'.06E, 1281-330 m, 1 sh. UPMC.

#### Etymology

Latin *tenuilabiatus* (= thin-lipped), due to its comparatively thin lip.

#### Description

Shell ovoid-elongate (L/D ca. 1.50), outline well rounded. Maximum diameter posterior to half shell length (Ld/L 0.60). Posterior rostration moderate. Siphonal notch absent. Lip weakly thickened; denticulations faint to lacking. Parietal callus hardly distinct, narrow, making a wide and deep sinus on body-whorl. Aperture rather wide. Four columellar plications, the uppermost two weaker. Surface polished, smooth, with ill-defined growth striae. Holotype: L 3.43 mm, D 2.30mm.

#### Distribution

Pleistocene to "Recent" (see below), epibathyal. Paleodepths within 500-600 m are inferred for the type-locality beds (DI GERONIMO & LA PERNA, 1997).

#### Remarks

The single shell from off Sardinia is old looking and might come from Würmian (Latest Pleistocene) beds, as suggested by the molluscan assemblage occurring in the sample. It only differs from the holotype by being smaller and with a comparatively thinner lip, lacking denticulations (faint denticulations are anteriorly present in the holotype). It is difficult to find a very close matching between fossil and Recent forms of *Granulina*, and no reason other than size can be found to keep this shell distinct from *G. tenuilabiata*.

### *Granulina occulta* (Monterosato, 1869)

Fig. 27

*Marginella occulta* Monterosato, 1869: p. 17, fig. 10.

*Volutella parvulina* Locard, 1897: p. 126, pl. 21, figs. 3-5.

*Granulina occulta* (Monterosato) - Gofas, 1992: p. 12, figs. 11 (lectotype), 12, 27.

#### Examined material

Off southeastern Sicily, PS81/10C, 36°43'.48N, 15°11'.30E, 61-58 m, 3 shs. UPMC.

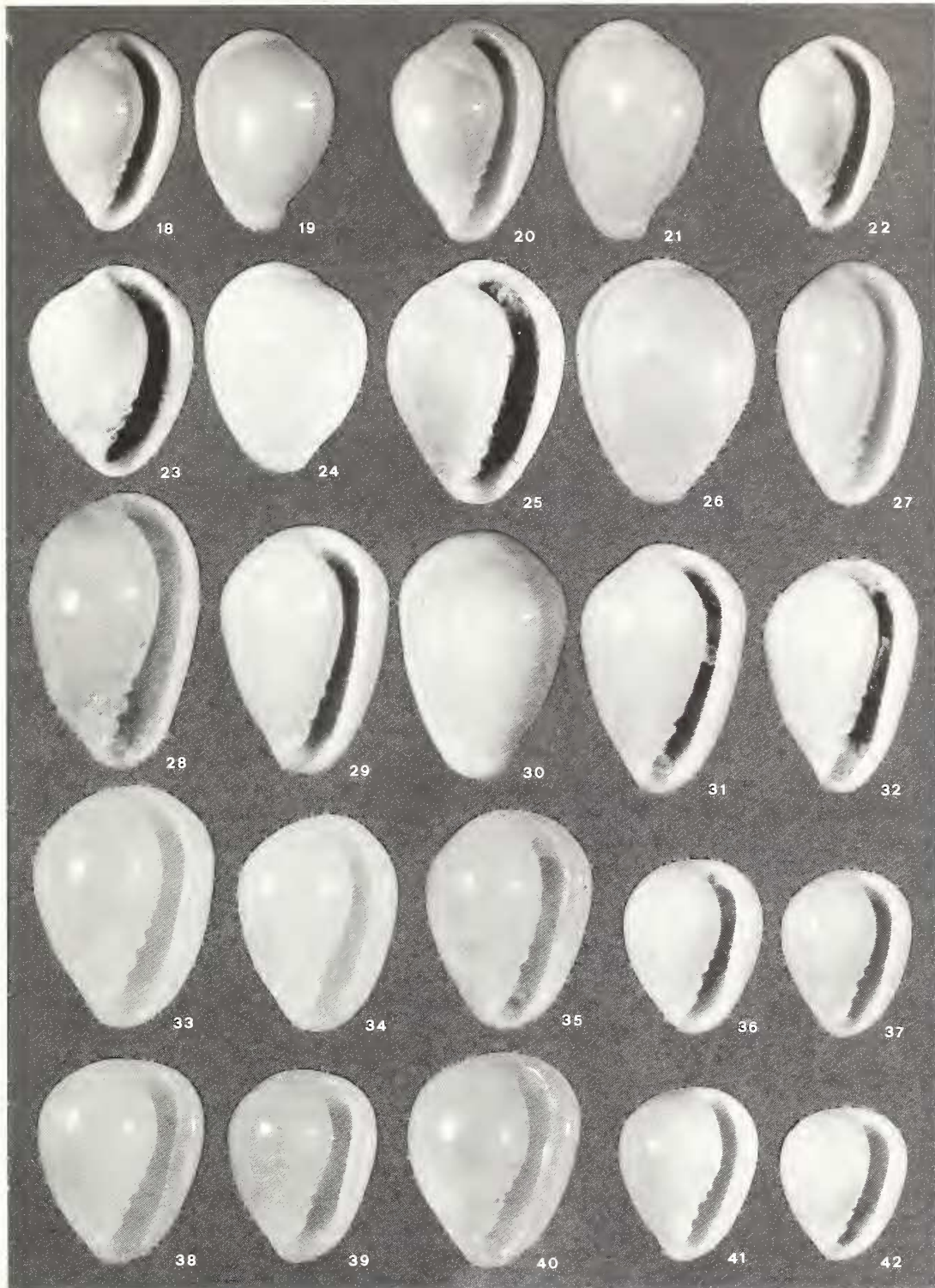
#### Distribution

*G. occulta* was described from off "Palermo, 50 m". It is a mid-to deep-shelf species, in Mediterranean and Ibero-Moroccan Gulf (GOFAS, 1992).

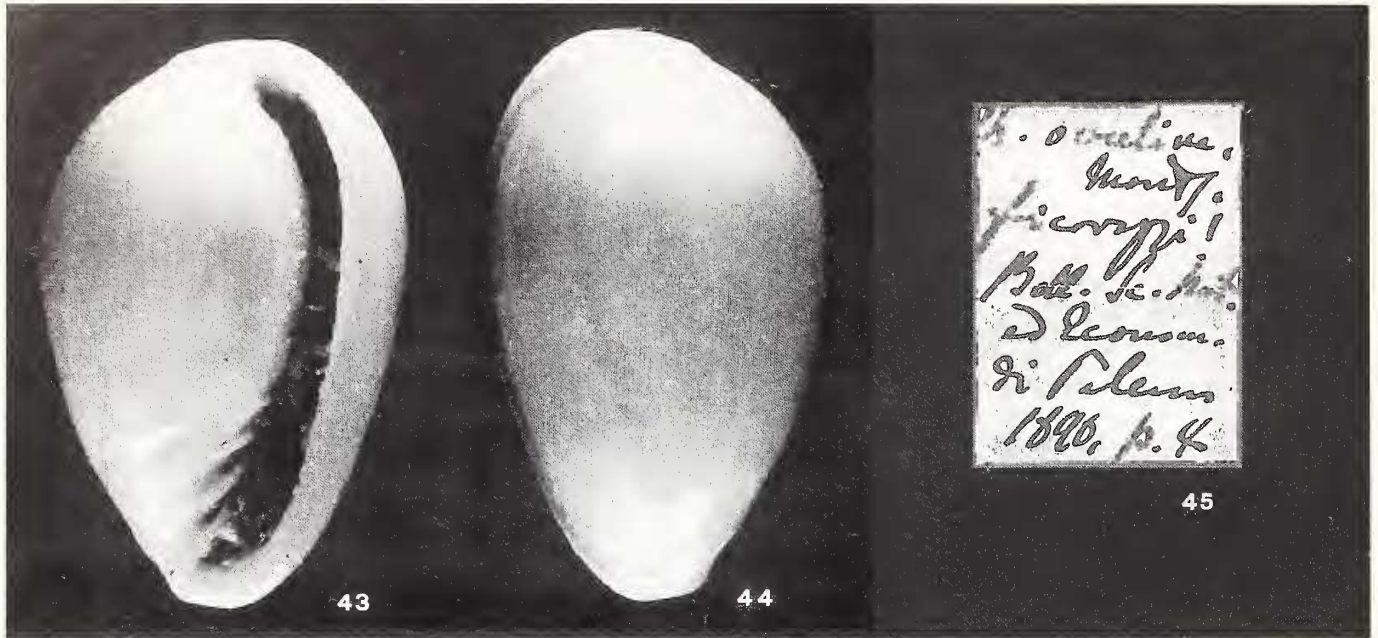
MONTEROSATO (1872, 1877) recorded this species as a fossil from Monte Pellegrino and Ficarazzi (Palermo) and a lot of 60 shells from "Monte Pellegrino" (labelled by Brugnone) is present in ZMR (C. Smriglio, pers. com.).

#### Remarks

*G. occulta* has a markedly slender shell, compared with the other species. The callus makes a wide and deep sinus on the body-whorl. Lip denticulations are weakly developed.



Figures 18-22. *Granulina melitensis* Smriglio, Mariottini & Rufini, 1998. Off southeastern Sicily, 200 m. 18, 19. 2.10x1.52 mm. 20, 21. 2.32x1.62 mm. 22. 2.01x1.40 mm. Figures 23, 24. *Granulina minusculina* (Locard, 1897). Aeolian Archipelago, 248 m. 2.21x1.73 mm. Figures 25, 26. *Granulina minusculina* (Locard, 1897). Furnari, Pleistocene. 2.54x1.87 mm. Figure 27. *Granulina occulta* (Monterosato, 1869). Off southeastern Sicily, 61-58 m. 2.52x1.50 mm. Figure 28. *Granulina* sp. B. Off eastern Sardinia, 1281-330 m. 2.83x1.77 mm. Figures 29-32. *Granulina jhomisensis* n. sp. Ippari River valley, Pleistocene. 29, 30. Holotype, 2.71x1.84 mm. 31. Paratype, 2.73x1.82 mm. 32. Paratype, 2.50x1.70 mm. Figures 33, 34. *Granulina boucheti* Gofas, 1992. Acitrezza, 24-38 m. 33. 2.50x1.88 mm. 34. 2.22x1.66 mm. Figure 35. *Granulina boucheti* Gofas, 1992. Grammichele, Pleistocene. 2.27x1.72 mm. Figures 36, 37. *Granulina* cf. *boucheti* Gofas, 1992. Ippari River valley, Pleistocene. 36. 1.80x1.44 mm. 37. 1.75x1.36 mm. Figs. 38, 39. *Granulina marginata* (Bivona, 1832). Acitrezza, 24-38 m. 38. 2.11x1.72 mm. 39. 2.00x1.55 mm. Figure 40. *Granulina marginata* (Bivona, 1832). Grammichele, Pleistocene. 2.22x1.77 mm. Figures 41, 42. *Granulina* cf. *marginata* (Bivona, 1832). Ippari River valley, Pleistocene. 41. 1.80x1.44 mm. 42. 1.61x1.33 mm.



Figures 43, 44. *Granulina ovulina* (Monterosato, 1891), lectotype. Ficarazzi (Palermo), Pleistocene. 3.30x2.10 mm. Monterosato coll. (ZMR). Fig. 45. Original label of *Gibberulina ovulina* Monterosato, 1891.

The synonymy between *Marginella occulta* Monterosato and *Volutella parvulina* Locard was proved by GOFAS (1992), but the rostrated and thick-lipped specimen from off Morocco (1,713 m) reported by BOUCHET & WARÉN (1985, fig. 711) as *G. parvulina* (Locard) seems a distinct Atlantic species.

Some deep-water shells from off eastern Sardinia (BS78/2, 41°51'.03N, 10°34'.06E, 1,281-330 m) are similar to *G. occulta*, but larger (up to 2.85 mm in length), more inflated (L/D ca. 1.60) and with a thinner well-arched lip, without denticulations (Fig. 29). Shells appear as old as *G. tenuilabata* from the same station. The taxonomic status of this material is not understood (a deep-water ecotype of *G. occulta*?) and it is tentatively referred to as *Granulina* sp. B.

### *Granulina marginata* (Bivona, 1832)

Figs. 38-40

*Volvaria marginata* Bivona, 1832: p. 24, pl. 3, fig. 5.

*Granulina marginata* (Bivona) - Gofas, 1992: p. 6, figs. 5-8, 25.

### Examined material

Grammichele ("Catallarga"), southeastern Sicily, Pleistocene, 14 shs. Belice River valley, southwestern Sicily ("Case Catarinicchia"), Pleistocene, 3 shs. Ippari River valley ("Cartiera Mulino"), southeastern Sicily, Pleistocene, 21 shs (*G. cf. marginata*). Off Acitrezza, eastern Sicily, SCUBA-diving samples, 24-38 m, 179 shs. Acitrezza harbour (beach), 21 shs. Brucoli, southeastern Sicily, *Posidonia* "mattes", 1-2 m, 8 shs. UPMC.

### Distribution

*G. marginata* is widespread in the western and eastern Mediter-

ranean, in shallow waters (GOFAS, 1992; KOUTSOUBAS *et al.*, 1997). GOFAS (1992), who examined and illustrated the material from Grammichele first, proved the occurrence in the Pleistocene.

### Remarks

See under *G. boucheti*.

### *Granulina boucheti* Gofas, 1992

Figs. 33-35

*Granulina boucheti* Gofas, 1992: p. 10, figs. 9-10, 26.

### Examined material

Grammichele ("Catallarga"), southeastern Sicily, Pleistocene, 7 shs. Belice River valley, southwestern Sicily ("Case Catarinicchia"), Pleistocene, 5 shs. Ippari River valley ("Cartiera Mulino"), southeastern Sicily, Pleistocene, 163 shs (*G. cf. boucheti*). Off Acitrezza, southeastern Sicily, SCUBA-diving samples, 24-38 m, 39 shs. Acitrezza harbour (beach), 16 shs. Brucoli, southeastern Sicily, *Posidonia* "mattes", 1-2 m, 23 shs. UPMC.

### Distribution

*G. boucheti* was described from Acitrezza and reported from other localities in Sicily, as well as from Corsica, Tunisia, Algeria (GOFAS, 1992) and the Aegean Sea (KOUTSOUBAS *et al.*, 1997). It occurs in shallow waters, often together with *G. marginata*, but less commonly (GOFAS, 1992).

GOFAS (1992) first proved its occurrence in the Pleistocene, on material from Grammichele.



## Remarks

The closeness of *G. boucheti* to *G. marginata* was stressed by GOFAS (1992), who noted orange spots on the foot, the base of tentacles and the inner mantle of *G. boucheti* (while these anatomical parts are colourless in *G. marginata*). Conchologically, *G. marginata* is a little smaller and broader (L 1.80-2.30 mm, L/D 1.20-1.31) than *G. boucheti* (L 1.90-2.55 mm, L/D 1.25-1.36). *G. marginata* is also more truncated posteriorly, and with a slightly bevelled lip. Same values of Ld/L are recorded for both species (0.65-0.69). In both species, the callus is notably wide, but not very distinct, and forms a thin ridge almost inside the aperture. The columellar folds are moderately doubled.

While the Pleistocene shells from Grammichele (Figs. 35, 40) and from the Belice River valley, all from shallow-water beds, match the Recent shells of *G. boucheti* and *G. marginata*, the abundant material from the Ippari River valley (same outcrop as for *G. jbonisensis*) is puzzling. Shells are all notably small (L 1.50-1.82 mm, D 1.20-1.45 mm), and most of them (ca. 87%) are slightly less truncated and more elongate (L/D 1.25-1.29) than the few remaining ones (L/D 1.20-1.29). The former group (Figs. 36, 37) is tentatively referred to as *G. cf. boucheti* and the latter as *G. cf. marginata* (Figs. 41, 42). It should be also noted that the columellar folds are strongly doubled in both groups, while they are slightly to moderately doubled in the Recent shells of both species. The Ippari River valley deposits are probably older than the Grammichele and the Belice River valley ones. The taxonomic status of the Ippari River material is still unclear. It might represent an ancestral form from which both *G. marginata* and of *G. boucheti* became more and more distinct in shape and size through the Quaternary. This could be better understood when other material, possibly from the Pliocene, will be available.

## *Granulina minusculina* (Locard, 1897)

Figs. 23-26

*Volutella minusculina* Locard, 1897: p. 127, pl. 21, figs. 6-8.

*Granulina minusculina* (Locard) - Gofas, 1992: p. 16, figs. 15, 16.

## Examined material

Furnari, northeastern Sicily, Pleistocene, 2 shs and fragments. Aeolian Archipelago, Southern Tyrrhenian, Eoucum95 st. 37, 38°29'.33N, 15°50.31E, 248 m, 1 shs. UPMC.

## Distribution

*G. minusculina* is known from the Atlantic (Ibero-Moroccan Gulf) and the Mediterranean (Western Basin), at bathyal depths (down to ca. 1,300 m) (GOFAS, 1992).

The undetermined *Granulina* listed by DI GERONIMO & LA PERNA (1997, tab. 1) from the bathyal Pleistocene of Furnari is *G. minusculina* (Figs. 25, 26). Depths close to 1,000 m are inferred for this deposit.

## Remarks

*G. minusculina* is characterised by a markedly inflated shell, with an almost central maximum diameter (Ld/L ca. 0.58). As noted by GOFAS (1992), denticles extend slightly to the outer surface of the lip.

The examined Pleistocene shells in these respects, but they are slightly larger and more egg-shaped than the Recent ones.

*G. occulta* of BOUCHET & WARÉN (1985, figs. 713) is *G. minusculina*, as noted by GOFAS (1992).

## *Granulina gofasi* Smriglio & Mariottini, 1996

Figs. 4-9

*Granulina gofasi* Smriglio & Mariottini, 1996: p. 55, figs. 1ab, 2-8.

## Examined material

Belice River valley (locality "Case Catarinichia"), south-western Sicily, Pleistocene, 2 shs. Off Lazio coast, 550 m (ex C. Smriglio coll.), 5 shs. Off eastern Sardinia, BS78/2, 41°51'.03N, 10°34'.06E, 1,281-330 m, 4 shs. UPMC.

## Distribution

*G. gofasi* was described from 300-600 m in the Central Tyrrhenian Sea (off Lazio coast). For the fossil record, see under *G. rosarioi*.

## Remarks

*G. gofasi* is characterised by a marked egg shape and a well arched posterior lip. Size is up to ca. 3.0 mm in length and 2.0 mm in diameter, L/D 1.44-1.53 and Ld/L ca. 0.65. The two Pleistocene specimens differ from the Recent one by being slightly larger, the lip almost lacking in denticulation (it is faint in the Recent material), and the shape more egg-shaped.

## *Granulina guttula* n. sp.

Figs. 13-16

## Type material

Holotype and 18 paratypes (one badly broken, one subadult). UPMC.

## Type locality

Off Isola di Ponza, eastern Tyrrhenian, 40°52'.23N, 12°55'.85E, 84 m.

## Etymology

Latin diminutive of *gutta* (= drop), due the drop-shaped shell.

## Description

Shell ovoid-elongate (L/D 1.48-1.55), outline rounded. Posterior rostration well-defined. Maximum diameter posterior to half shell length (Ld/L 0.62-0.67). Siphonal notch distinct. Lip moderately thickened, posteriorly bevelled; denticulations



	P	R	distribution
<i>Granulina rosarioi</i> n. sp.	+		deep shelf
<i>Granulina jhomisensis</i> n. sp.	+		shallow shelf
<i>Granulina ovulina</i> (Monterosato, 1891)	+		deep shelf
<i>Granulina tenuilabiata</i> n. sp.	+	(+)	epibathyal
<i>Granulina occulta</i> (Monterosato, 1869)	+	+	shelf/(epibathyal)
<i>Granulina marginata</i> (Bivona, 1832)	+	+	shallow shelf
<i>Granulina boucheti</i> Gofas, 1992	+	+	shallow shelf
<i>Granulina minusculina</i> (Locard, 1897)	+	+	bathyal
<i>Granulina gofasi</i> Smriglio & Mariottini, 1996	+	+	deep shelf/epibathyal
<i>Granulina guttula</i> n. sp.		+	deep shelf
<i>Granulina melitensis</i> Smriglio, Mariottini & Rufini, 1998		+	deep shelf

Table 1. Species of *Granulina* occurring in the Pleistocene (P) and in the Recent (R) Mediterranean, with the ecological distribution.

faint but well defined. Aperture narrow. Four indistinctly doubled columellar plications. Surface smooth, polished. Parietal callus narrow. Holotype: L 1.92 mm, D 1.26 mm. Paratypes: L 1.91-2.25 mm, D 1.28-1.45 mm.

### Distribution

Only known from the type locality.

### Remarks

*G. guttula* appears rather similar to *G. occulta*. The former has a more bevelled lip and is markedly inflated posteriorly. It can be also distinguished from *G. melitensis* by being more slender and by lacking the thick posterior callus.

A fossil shell (Fig. 17) from Vallone Catrica (same outcrop as for *G. tenuilabiata*) looks rather similar to *G. guttula* (and to *G. rosarioi* as well), but it is notably larger and with a more central maximum diameter. It might be an undescribed species, but the available material is too scarce to attempt its interpretation. It is referred to as *Granulina* sp. A.

### *Granulina melitensis* Smriglio, Mariottini & Rufini, 1998

Figs. 18-22

*Granulina melitensis* Smriglio, Mariottini & Rufini, 1998: p. 53, Figs. 1-7.

### Examined material

Off southeastern Sicily: PS81/4B, 36°54'.67N, 15°11'.60E, 76 m, 2 shs.; PS81/4C, 36°54'.17N, 15°12'.20E, 95-86 m, 4 shs.; PS81/4X, 36°57'.32N, 15°19'.32E, 102-93 m, 3 shs.; PS81/2XB, 36°56'.80N, 15°20'.00E, 126-120 m, 3 shs.; PS81/5X, 36°56'.57N, 15°21'.12E, 160 m, 1 sh.; 10P, 38°42'.88N, 15°17'.44E, 200 m, 13 shs. UPMC.

### Distribution

*G. melitensis* was described on shells from 100-120 m in Gnejna Bay, Malta, and was also reported from the Central Tyrrhenian in 250 m (previously as *G. minusculina*: SMRIGLIO & MARIOTTINI, 1996, figs. 4a,b). The living specimen reported by MIFSUD (1996: fig. 18) from Malta as *G. minusculina* is *G. melitensis* (S. Gofas, pers. com.). Also *G. occulta* of BOUCHET & WARÉN (1985: fig. 712) from off south-western Sicily is *G. melitensis*. It is rather commonly found on deep-shelf (70-250 m) muddy-sandy bottoms.

### Remarks

*G. melitensis* has a thick posterior callus, sometimes making almost a shallow "tubercle". None of Mediterranean and Eastern Atlantic species shows such a feature. This species differs from *G. minusculina* mainly by being less inflated, less "rhomboidal" in shape and with a fairly well distinct siphonal canal. Further, some soft-part features make the two species well distinct (S. Gofas, pers. com.).

### DISCUSSION

Eleven species of *Granulina* are proved to occur in the Quaternary Mediterranean (Tab. 1). Six of the eight extant species range back to the Pleistocene, namely *G. tenuilabiata*, *G. occulta*, *G. marginata*, *G. boucheti*, *G. minusculina* and *G. gofasi*. Three species, i.e. *G. rosarioi*, *G. jhomisensis* and *G. ovulina* are only known from the Pleistocene, while *G. guttula* and *G. melitensis* are only known as Recent species.

*Granulina clandestina* (Brocchi, 1814), a Pliocene species, deserve some comments. GOFAS (1992) faced with Brocchi's species identity proposing a neotype. COOVERT & COOVERT (1995: p. 74) disagreed with Gofas' interpretation, remarking some discrepancies between BROCCHI's figure (1814, p. 642, pl. 15, fig. 11) and GOFAS' neotype (1992, p. 5, fig. 3). Although the Pliocene species of *Granulina* are too poorly-known to face critically this problem, *G. clandestina sensu* Gofas was probably present in the Pleistocene too as





CERULLI-IRELLI's record (1911, p. 281, pl. 21, figs. 9-14) of *Cryptospira clandestina* (from Early Pleistocene beds: see BONADONNA, 1968) seems to be based on this species.

A poorly known Pleistocene deep-water species from southern Calabria, *Marginella ovulaeformis* G. Seguenza, 1879 also needs some comments. The original description and drawing (SEGUENZA, 1879: p. 253, pl. 16, fig. 12) suggest a large *Granulina* (ca. 5 mm in length), but the examination of topotypic material (L. Seguenza coll., UPMC; LA PERNA, in prep.) leads to exclude such an allocation, because of the size, the elongate-pyriform shape, the smooth and not inflected lip. A preliminary allocation could be in the marginellid *Ovaginella* Laseron, 1957 (see COOVERT & COOVERT, 1995).

The diversification of *Granulina* in the Mediterranean and its trend to occupy the deep shelf and the upper slope are remarkable. None of the three shallow-water species (*G. marginata*, *G. boucheti* and *G. jbmisensis*) seems to be markedly close to the shallow-water extra-Mediterranean ones (including Gibraltar), i.e. *G. vanbareni* (Van Aartsen, Menkhorst & Gittenberger, 1984), *G. torosa* Gofas, 1992, *G. guancha* (d'Orbigny, 1840), *G. mauretanic* Gofas, 1992 (see GOFAS, 1992). Although *G. jbmisensis* differs notably in shape from *G. marginata* and *G. boucheti*, two features are anyway shared between them, i.e. the wide parietal callus and the apertural callose ridge. *G. tenuilabiata*, *G. gofasi*, *G. rosarioi*, *G. ovulina*, *G. occulta*, *G. melitensis* and *G. guttula* range, as a whole, from the outer shelf to the upper slope, while *G. minusculina* is the sole truly bathyal species. Some of these species, i.e. *G. rosarioi*, *G. ovulina*, *G. guttula* and *G. occulta* seem to form a distinct morphological group with outer-shelf distribution. *G. gofasi* and *G. tenuilabiata* also seem rather close to each other, and both have a deeper distribution. *G. minusculina* clearly belong to a distinct lineages, owing to the squat shape and the lip denticulations extending slightly to the outside (soft-part differences were also reported by GOFAS, 1992). *G. melitensis* is morphologically similar to *G. minusculina* and might represent an "intermediate" form between this species and the outer-shelf group.

*G. occulta* and *G. minusculina* are the sole species spreading into the Ibero-Moroccan Gulf (GOFAS, 1992), while most species, including the extra-Mediterranean ones have narrow to endemic geographical distribution. Slow gene flow and high speciation rate (probably due to non-planktotrophic larval development) are suggested by this distribution pattern and by the differences between Pleistocene and Recent populations outlined in the present work.

## CONCLUDING REMARKS

Some aspects of *Granulina* in the Quaternary Mediterranean remain open; particularly the taxonomic status of the deep-water forms tentatively referred to as *Granulina* sp. A and *Granulina* sp. B, and that of the small Pleistocene form referred to the *marginata-boucheti* complex. Further studies on Plio-Quaternary material will surely help to clear up these problems, as well as to achieve a better knowledge of *Granulina* in the Mediterranean.

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## Notes added in proof

While the present paper was in press, additional material was examined. Some of it is worth of being reported.

1. *G. melitensis*. Grammichele ("Ciaramitaio", southeastern Sicily), Pleistocene deep-shelf silts, 3 shs. This species is thus proved to range back to the Pleistocene.
2. *G. cf. occulta*. Mineo (southeastern Sicily), Pleistocene, 22 shs (De Fiore coll., UPMC). Shells are notably larger (up to 3.4 mm) than the Recent ones.
3. *G. ovulina*. Grammichele ("Catalarga", southeastern Sicily), Pleistocene shallow-water sands, 1 sh.